

3^η Διάλεξη

9 Δεκ. 2014

Προσδιορισμός Νανοσωματιδίων με ICP-MS

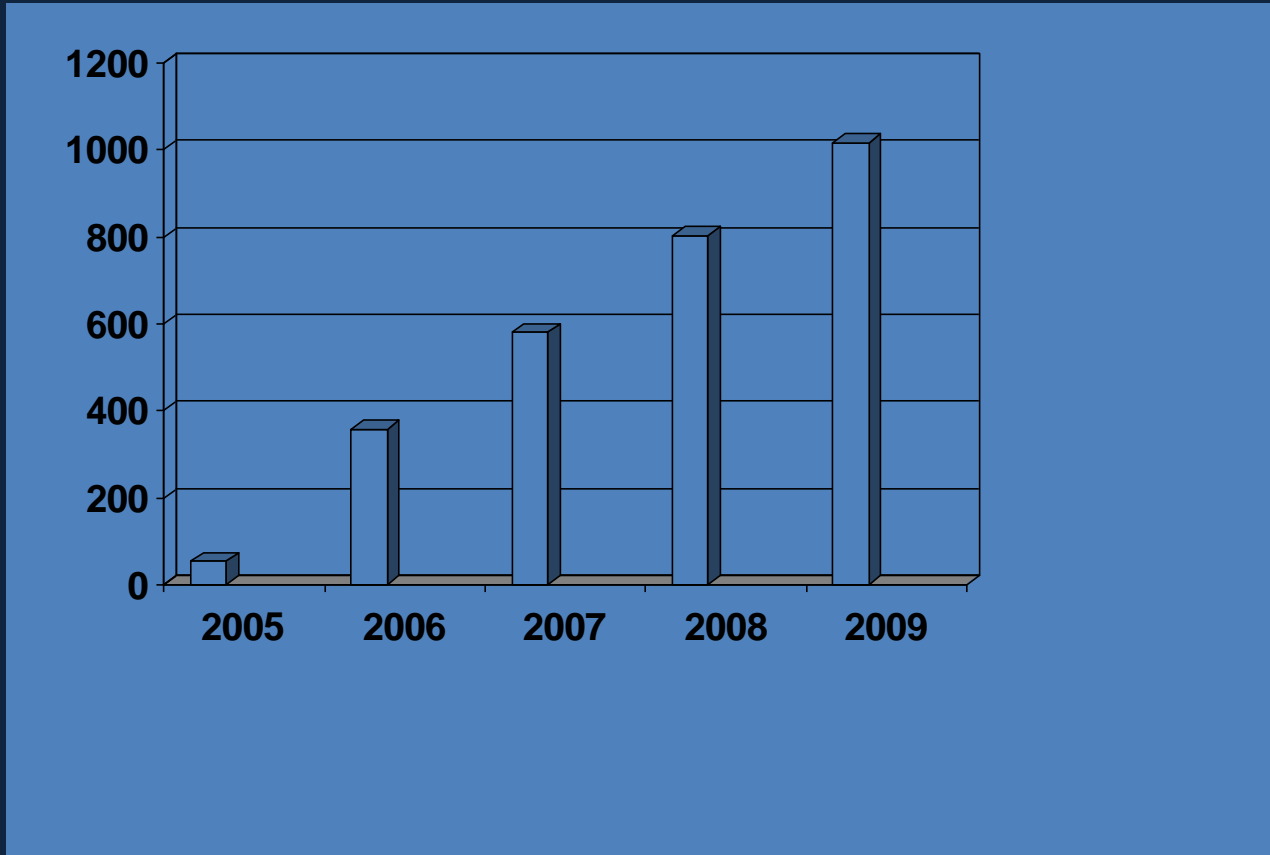
Hydrodynamic Liquid Chromatography with
Single Particle (SP)
Inductively Coupled Plasma – Mass Spectrometry (ICP-MS)

for Determining Nanoparticle Concentration, Size and
Elemental Composition

Nano-material	Number of products	Common uses (with selected examples)
Ag	121	Nutritional supplements; personal care products (tooth brushes, tooth paste); biocide coating on membranes (gloves, masks, condoms); clothing (socks, underwear, baby apparel); toys and pacifiers; dispersed biocide (washing machines)
TiO ₂	32	Resin coatings; personal care products (skin cream, hair dryers); nutritional supplements; catalysts (self-cleaning coatings)
ZnO	30	Sun block
Carbon nanotubes	19	Material construction (sporting goods, automobile and aircraft parts)
Au	15	Nutritional supplements, personal care products (skin cream); catalysts.
Fullerenes	7	Cosmetics
CeO	1	Fuel additive

Nanotechnology revolution?

Inventory of consumer products containing ENMs



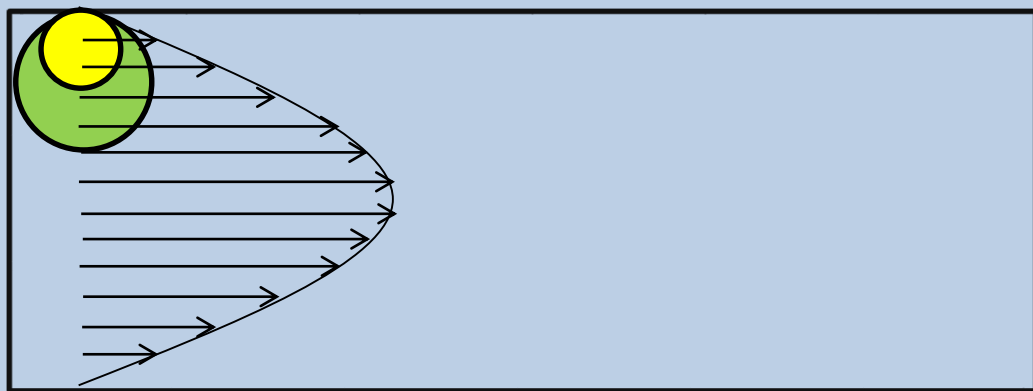
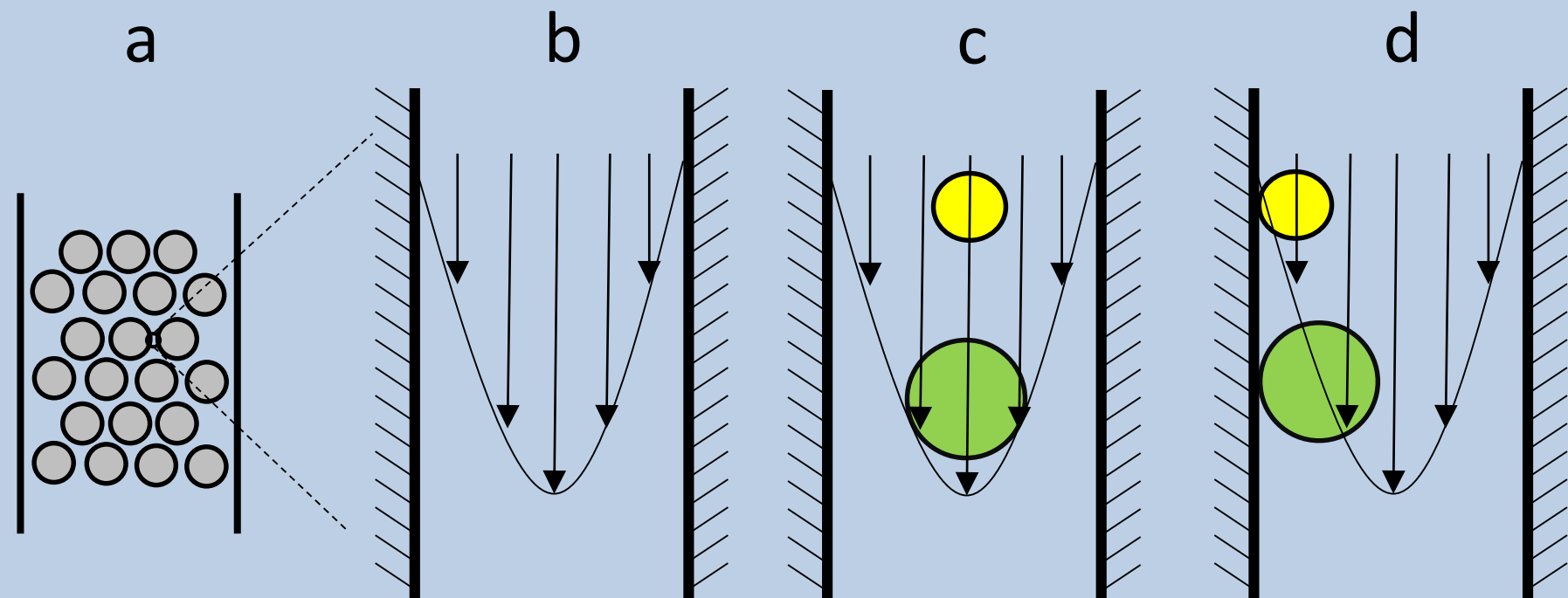
Source: the Project on Emerging Nanotechnology, Woodrow Wilson International Center for Scholars

Question: Environmental implications of increased use of engineered nanomaterials

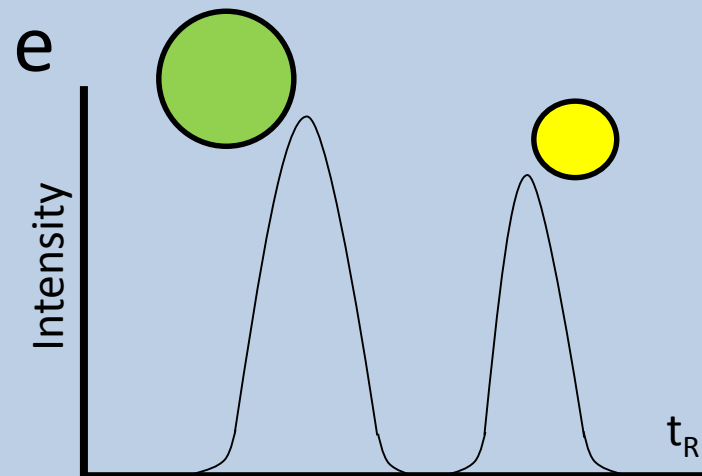
Common ENM characterization metrics and selected characterization methods.

Characterization metric	Measurement methods
Size distribution - diameter	SEM, TEM, AFM, DLS, SLS, NTA, flow-FFF, sed-FFF, CE, HDC
Size distribution - mass	Sed-FFF
Specific surface area	adsorption isotherm
Surface charge	ζ potential by DLS
Shape	SEM, TEM, AFM, SLS with DLS or FFF

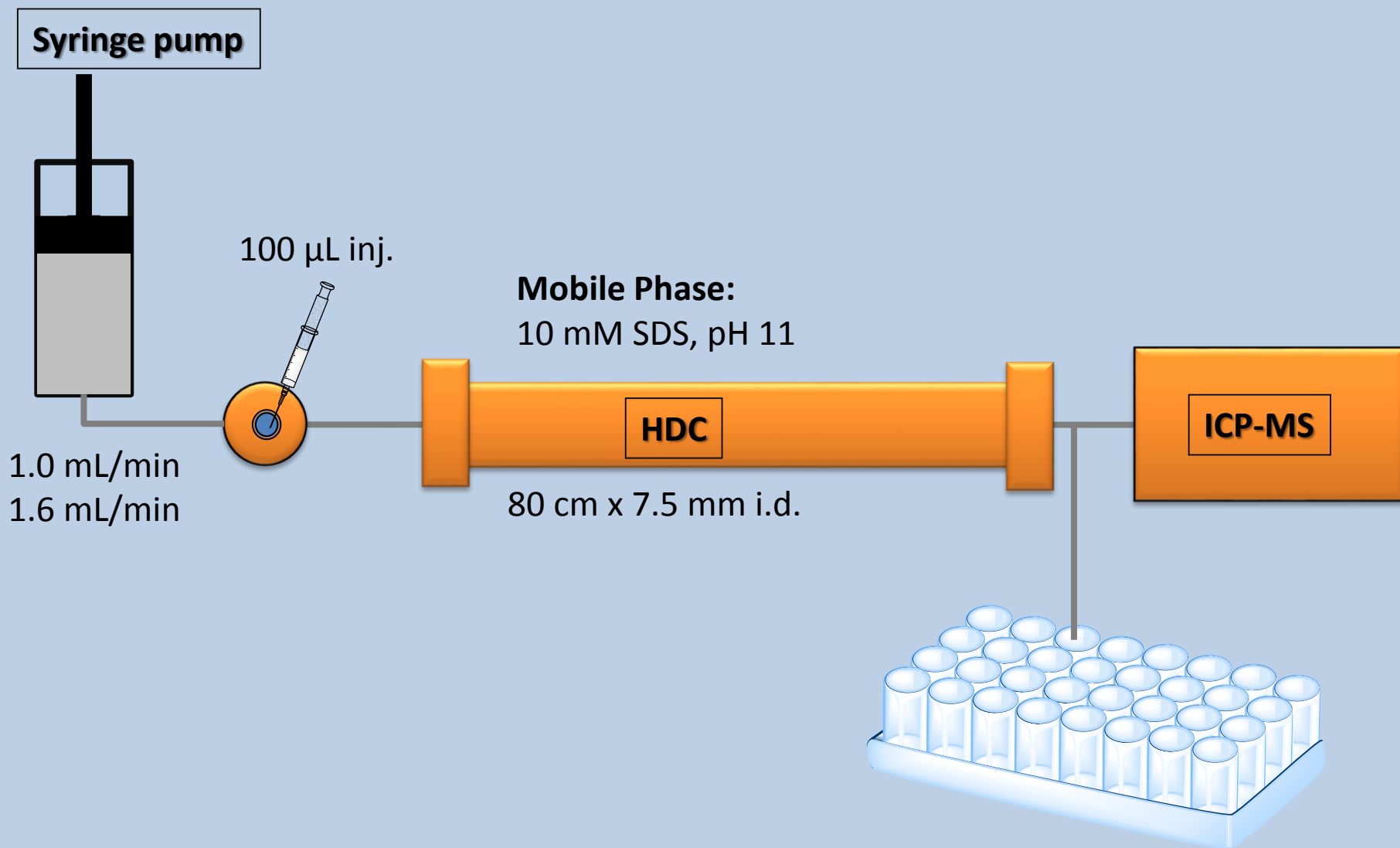
Hydrodynamic Chromatography (HDC)



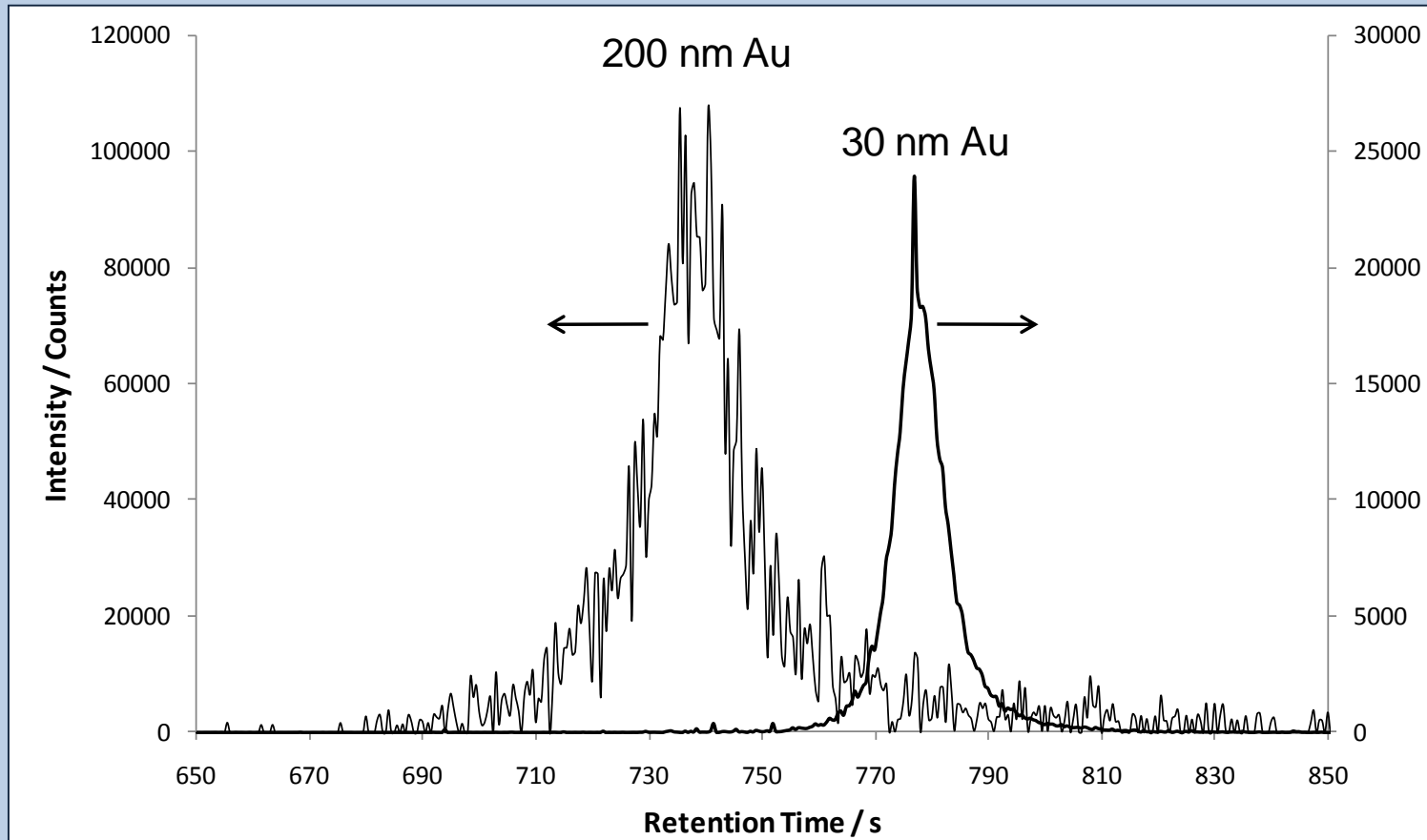
Separation only depends on size



HDC on-line with ICP-MS



Hydrodynamic Chromatography (HDC)



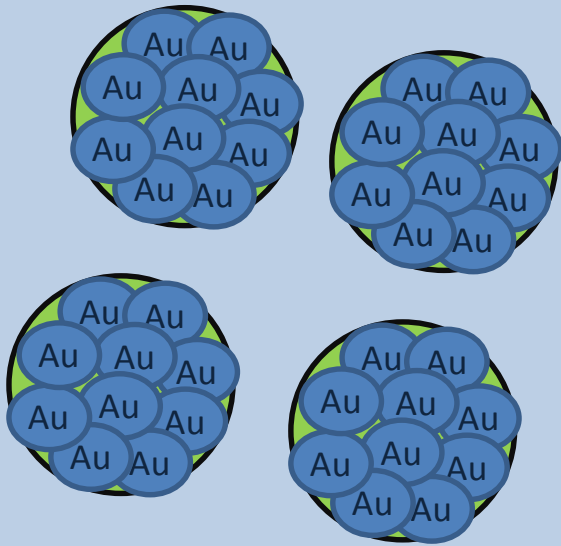
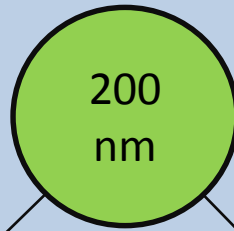
Limitation:

No information about particle numbers (**NP number concentrations**)

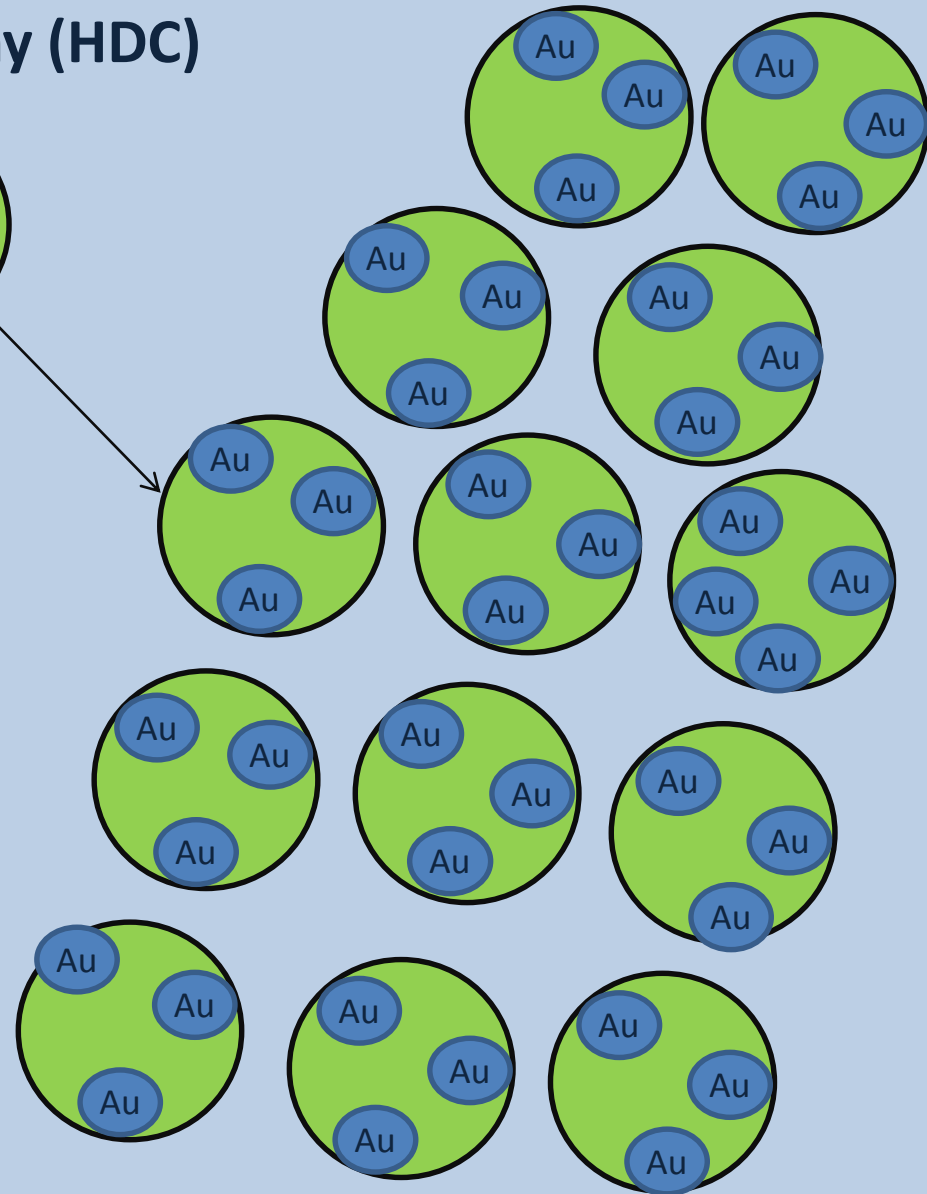
→ No info regarding **metal mass fraction** in NPs

Hydrodynamic Chromatography (HDC)

NP size
amount of metal

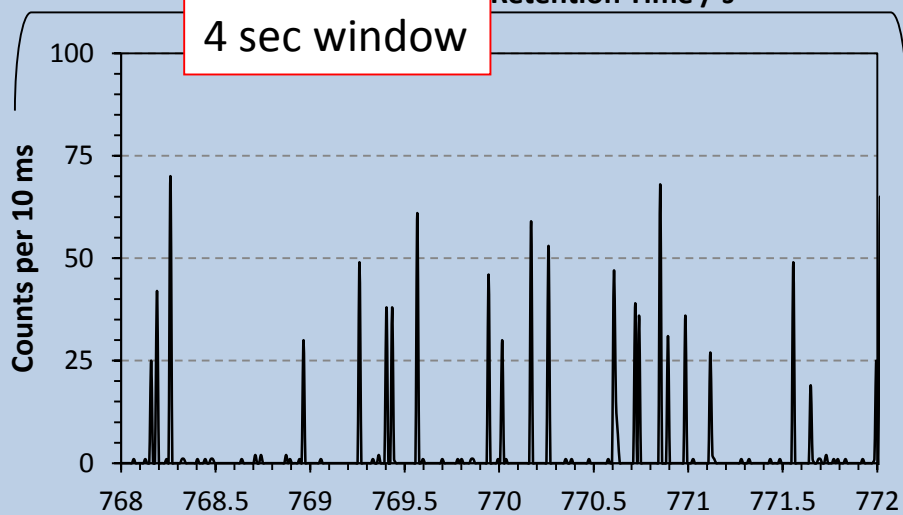
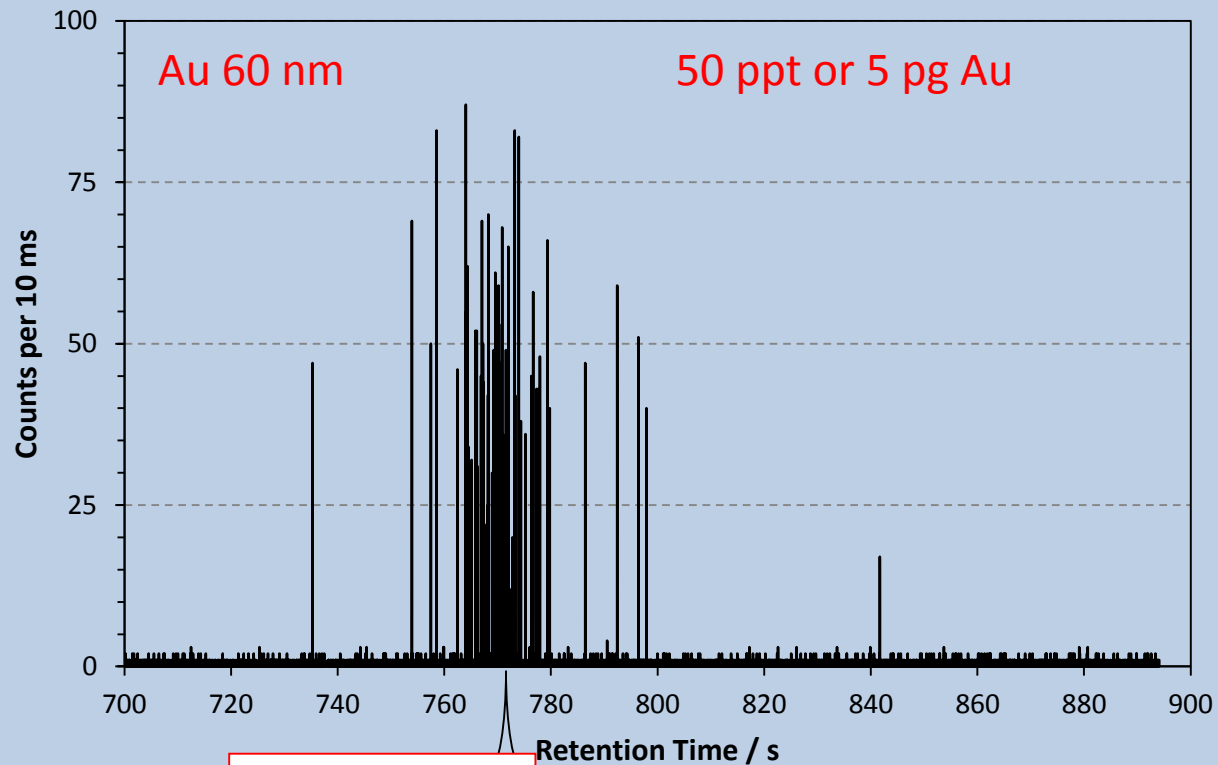


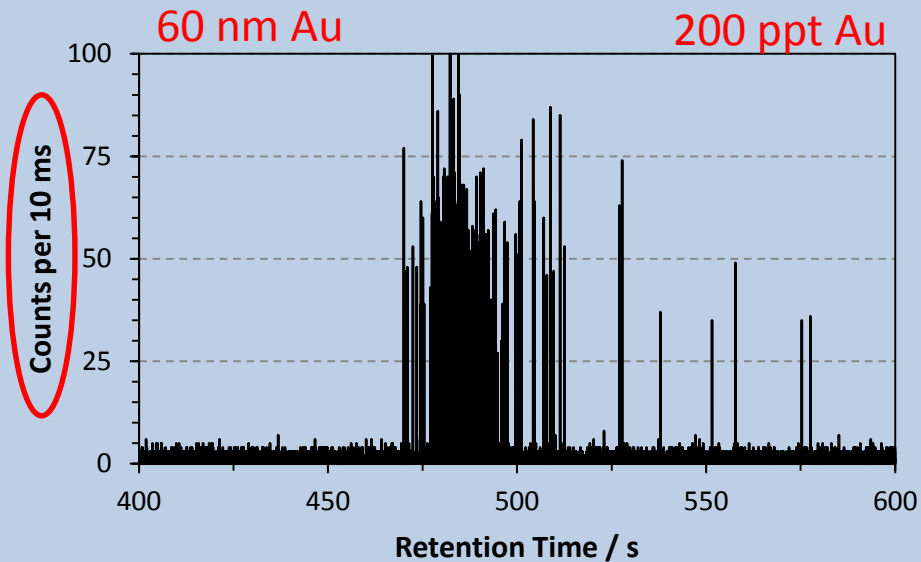
Few particles with large amounts of Au in each



Many particles with small amount of Au in each

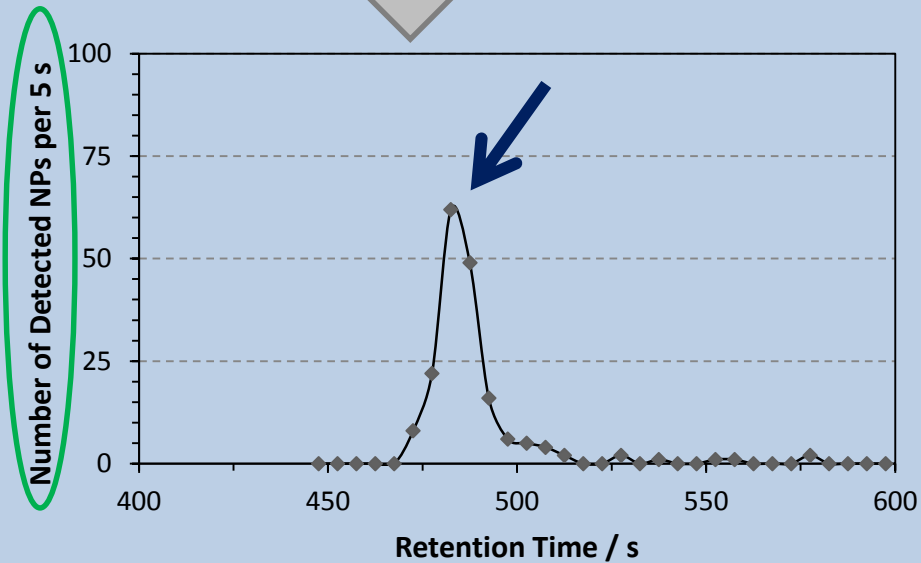
HDC – spICP-MS

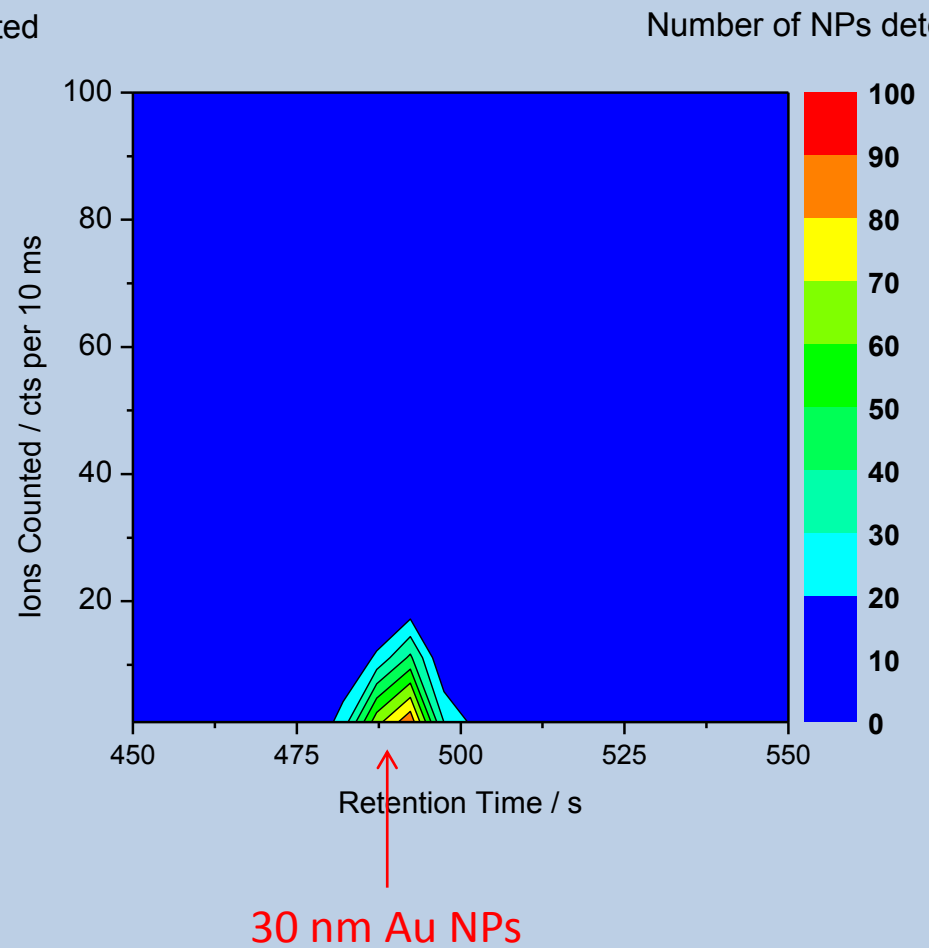
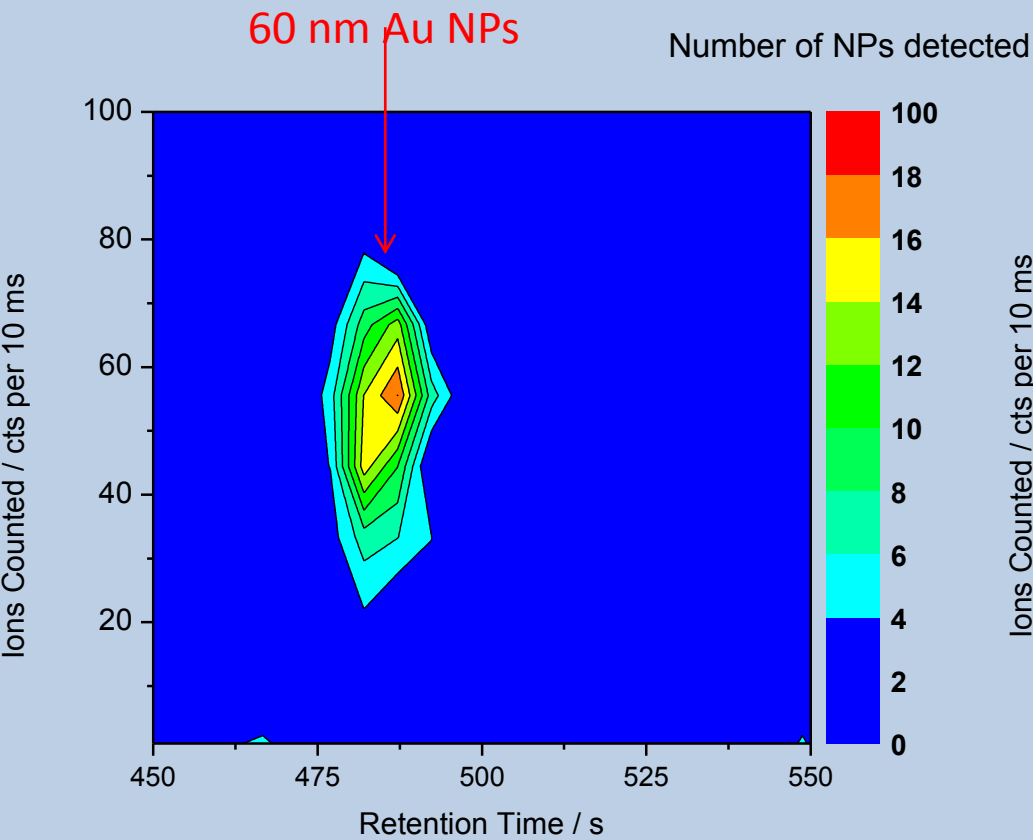
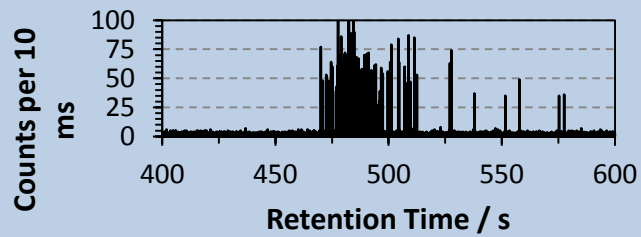




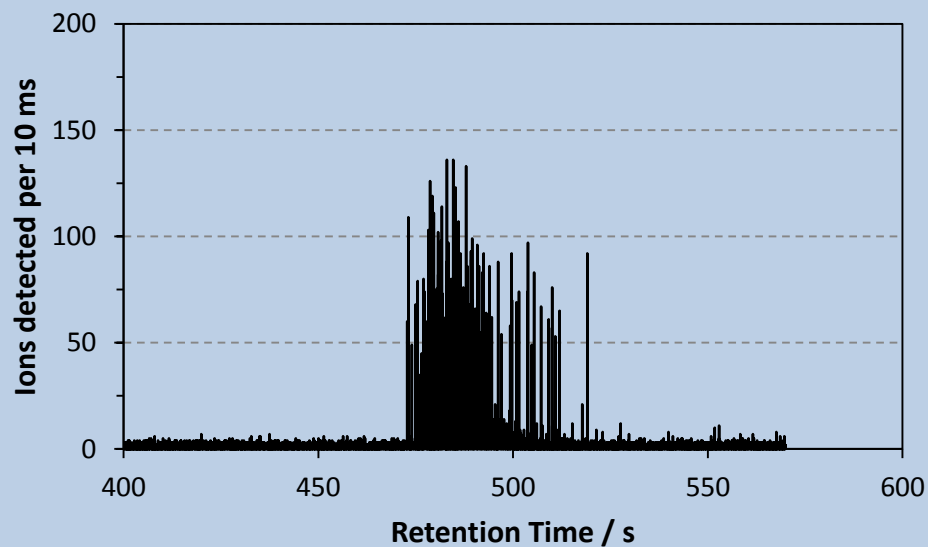
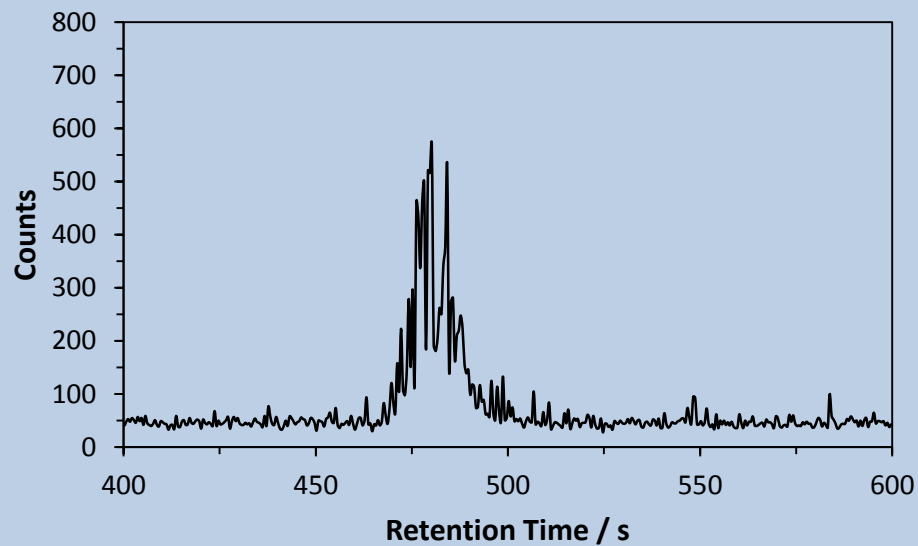
- Metal content of individual NPs
- NP number concentration
- NP size

Sum of NPs in 5 s bins

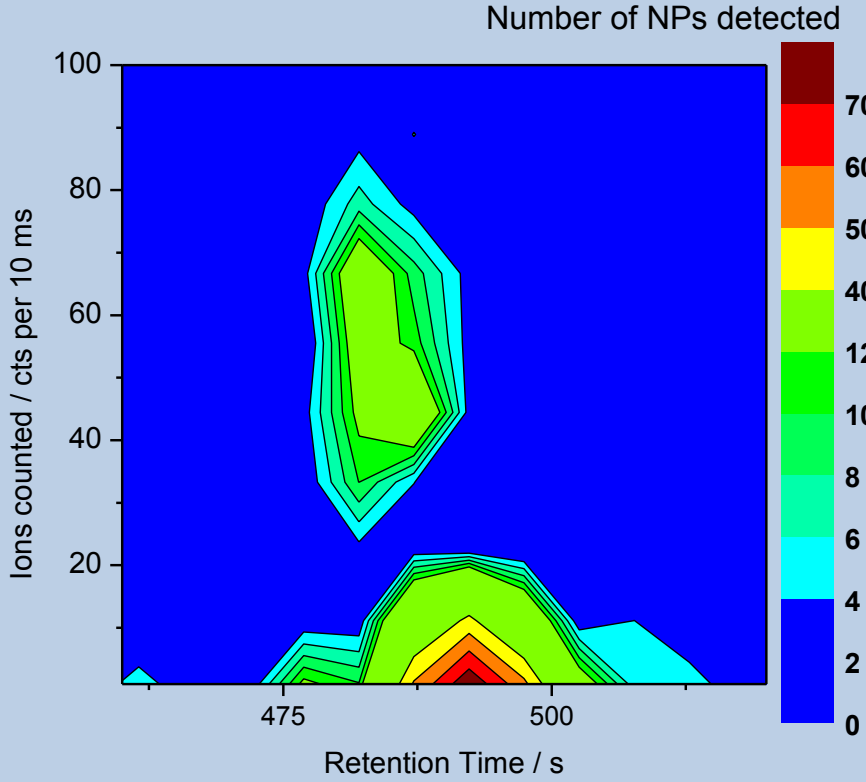




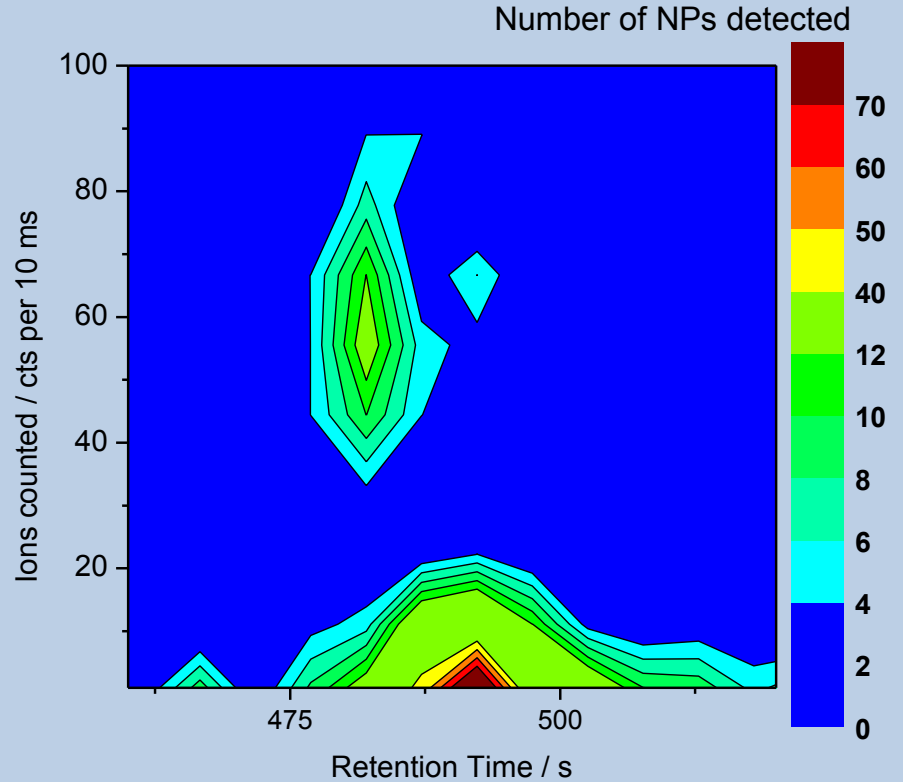
Mixture:
30 nm Au and 60 nm Au



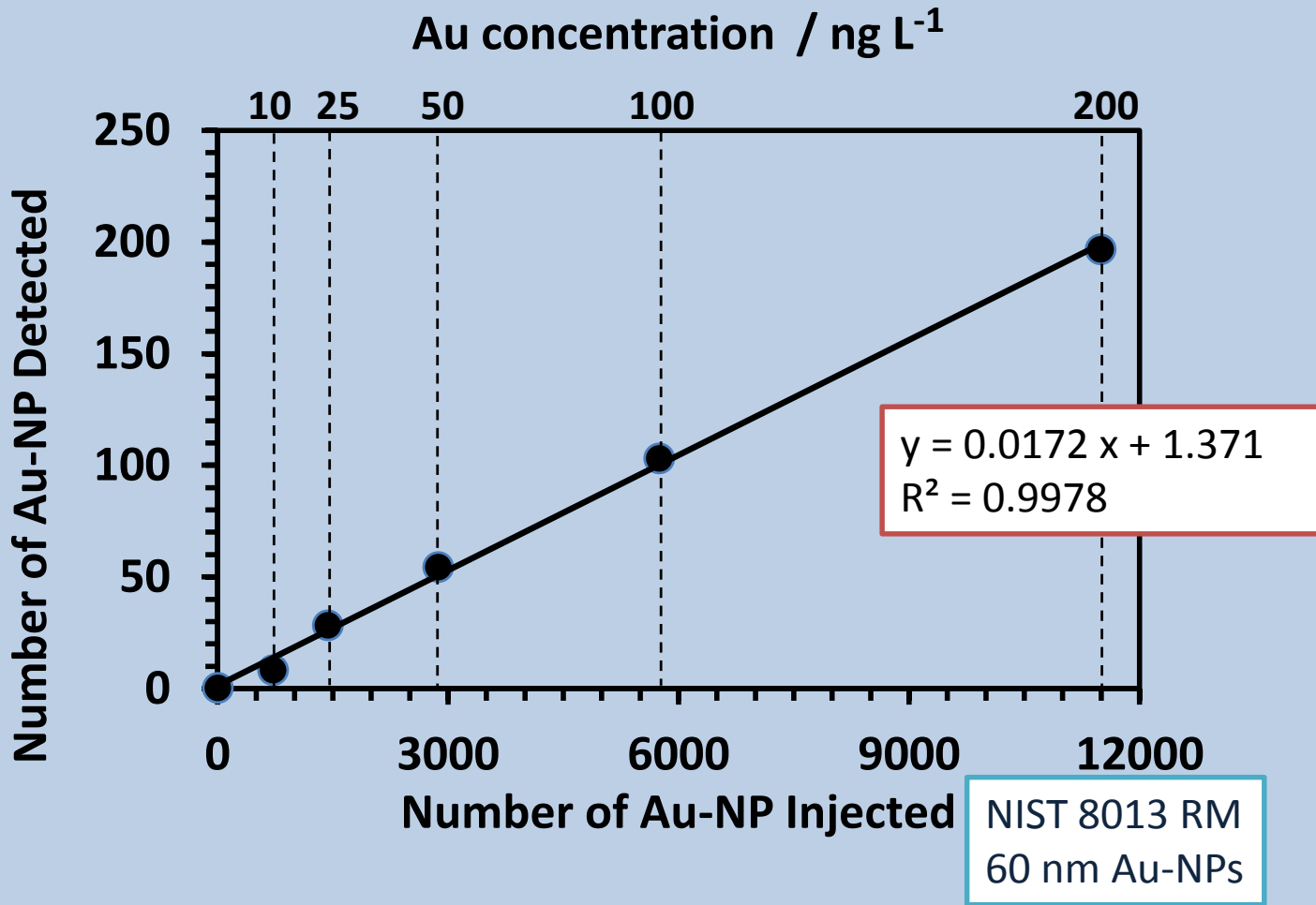
Mixture:
60 nm Au at 200 ppt
30 nm Au at 50 ppt



Same mixture of Au NPs spiked into
bottled drinking water



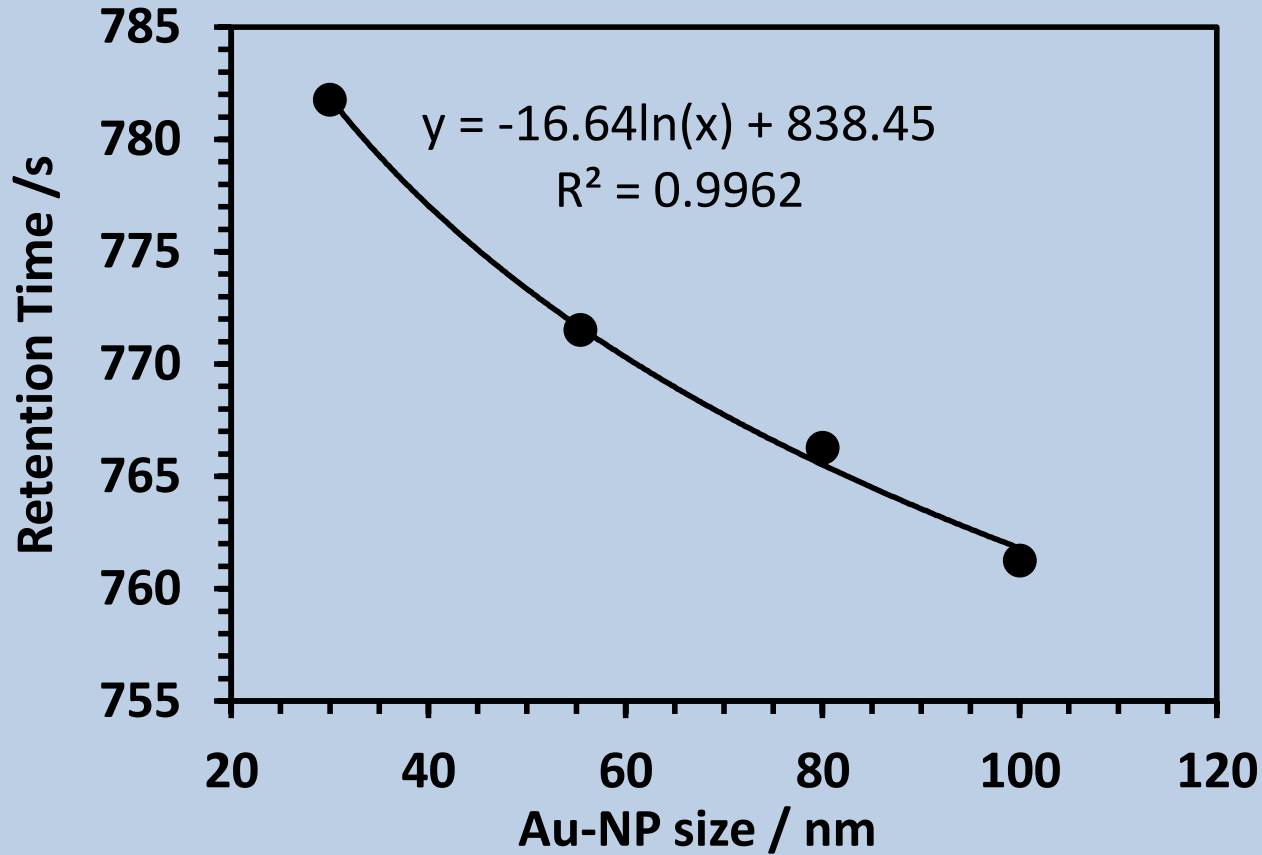
Determine Au-NP number concentration



LOD: 1.2 ppt or 60 NPs

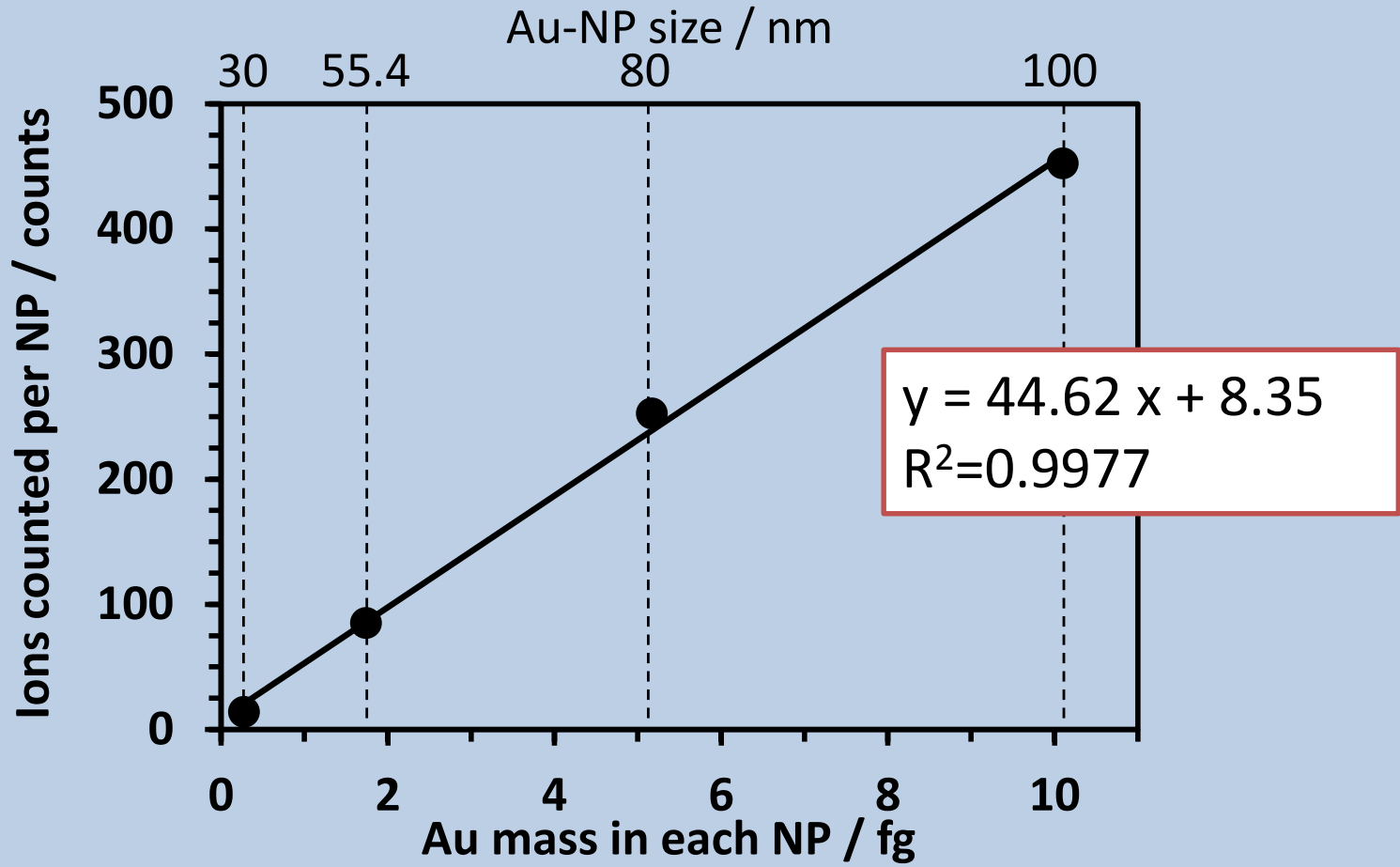
○ **High sensitivity and low LOD**

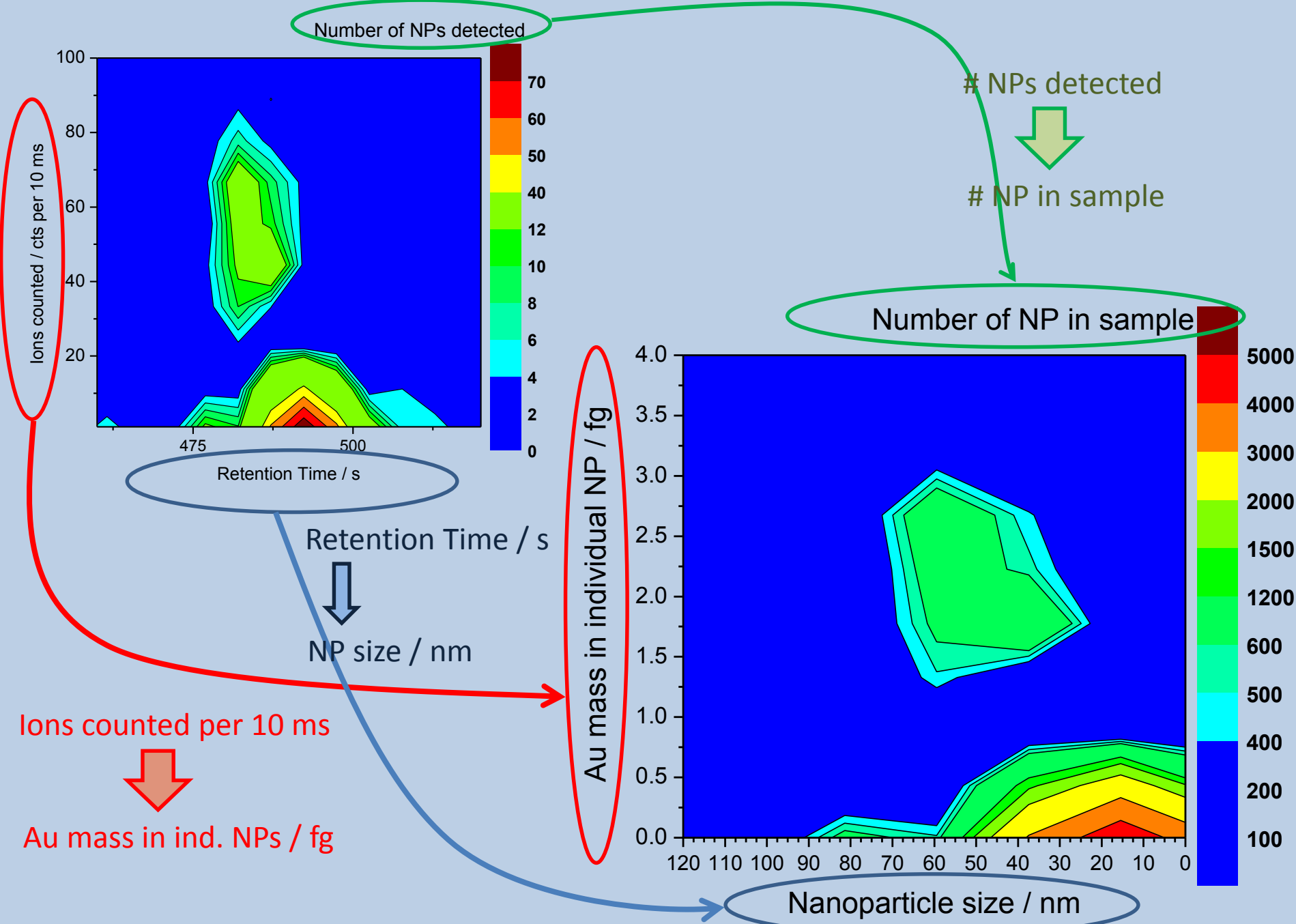
Determine NP size



Convert from NP retention time to NP size

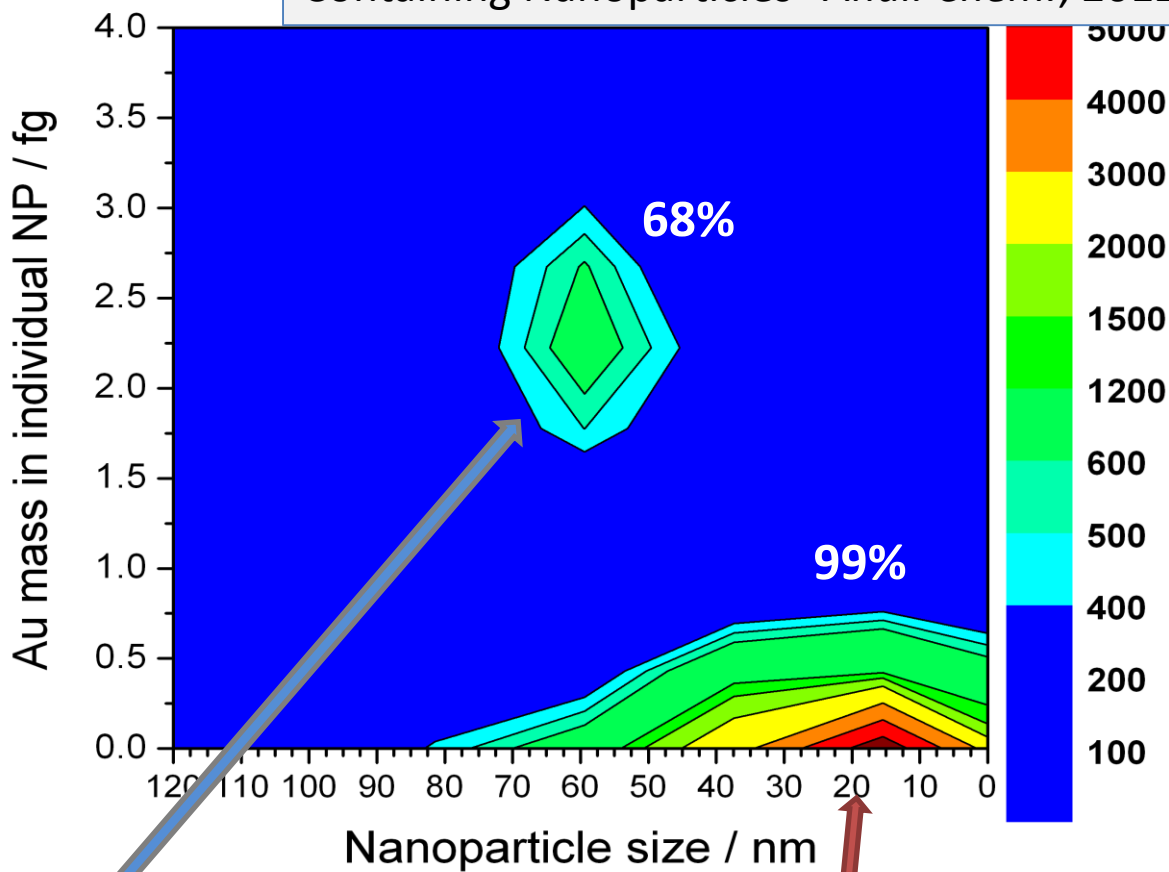
Au mass in individual NP





Determina

S. A. Pergantis*, T. L. Jones-Lepp, E. M. Heithmar, "Hydrodynamic Chromatography On-Line with Single Particle Inductively Coupled Plasma – Mass Spectrometry for Ultratrace Detection of Metal-Containing Nanoparticles" *Anal. Chem.*, 2012, 84(15), 6454-6462.



NIST RM 8013
55-65 nm
55.4 ± 1.1 nm
2.0 - 2.5 fg Au
1.74 fg of Au

NIST RM 8012
10-30 nm
26.8 ± 1.5 nm
0.15-0.3 fg Au
0.27 fg Au